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OBSERVATIONS ON SOME AQUATIC ANIMAL AND PLANT ENEMIES OF MOSQUITOES

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FOREWORD

Animal and plant enemies undoubtedly play an important part in controlling mosquitoes, but it is fully recognized that a study of these organisms forms only one phase of a very complex subject spoken of generally as natural control. Climate, weather conditions, topography, etc., all have an important bearing on mosquito abundance. Precipitation, whether in the form of rain or snow, and temperatures, exert a vital influence on mosquito populations. If the winter accumulation of snow is heavy, the spring infestation of snow pool and floodwater mosquitoes may be expected to be heavy too. If slight, or dissipated gradually by early and intermittent thaws, the probabilities are that a light infestation will result. The quantity and periodicity of spring and summer rains have a decided bearing on mosquito abundance. Dry seasons are comparatively mosquito free; wet seasons characterized by frequent and heavy rains produce great numbers of certain species of mosquitoes. Humidity and the water content of the soil also have a marked significance. Summer rainstorms preceded and followed by dry warm weather often cause the formation of shallow transient pools in which enormous numbers of larvae hatch and are left stranded to die, owing to the rapidity with which the water evaporates or drains away into the soil.

In connection with natural enemies, we are concerned here solely with organisms which live in an aquatic environment where mosquitoes develop in their early life stages. During recent years a growing interest in such organisms is evident among entomologists and others concerned with problems related to mosquito control. The recent excellent papers of Matheson and Hinman (4, 5, 6 & 7) concerning this subject have done much to revive and stimulate that interest and to encourage other workers in making observations of a similar character. In our studies of mosquitoes, chiefly in the vicinity of Ottawa, we have, at various times, had opportunities of making notes regarding certain aquatic species of animal and plant life that have, or are reported to have, a deleterious effect on mosquitoes, and it has been considered worth-while to bring them together in the present paper, as a contribution to this interesting and important subject. In much of the work connected with the investigations which led to the preparation of this paper the writer has been ably assisted by Mr. G. H. Fisk, temporary Insect Pest Investigator.

In Canada, permanent bodies of water are, generally speaking, the least important in producing mosquitoes, particularly of species of the genus *Aedes*, the most prolific sourse being collections of water of a temporary or transient

character. In view of the greater predominence of predacious life in permanent waters, one might easily fall into the error of ascribing the comparative scarcity or absence of mosquito breeding in these waters largely to the prevalence of natural enemies. This would be far from the truth. The phenomenon may be explained partly, at least, by the life history and bionomical requirements of the majority of our northern species which inhibit them from developing in such waters, and to the selective instincts of the various species in choosing suitable breeding places. There is no doubt, however, that aquatic predacious life plays an important part in reducing mosquito populations in both temporary and permanent bodies of water. Indeed, but for their widespread prevalence and abundance in waters of a permanent character suitable to species of such genera as *Anopheles* and *Culex*, it is probable that these mosquitoes would be of far greater importance as pests than is actually the case.

AQUATIC ANIMAL ENEMIES OF MOSQUITOES

Predacious Mosquitoes

There are several species of non-biting mosquitoes, of the sub-family Chaoborinae, in Canada, the larvae of which are predacious. Certain of these species are common in the Ottawa district and appear to be of definite value in mosquito control. The mouthparts, antennae and general body structure of these larvae are admirably adapted for preying upon other small forms of aquatic life. They occur commonly in temporary bodies of water infested by culicine larvae, where they lie horizontally, beneath the surface, in wait for prey, their transparent bodies almost invisible against the dark background of the bottom of the pool. Two pairs of air sacs, one in the thorax and the other in the posterior abdomen, form their most conspicuous feature. These larvae are able to move with great rapidity and frequently make sudden about-face movements in the water.

Fortunately the application of oil on breeding places in mosquito control work apparently has no serious effects on these beneficial larvae. We have frequently noticed them quite unharmed in oiled breeding pools after the culicines had all succumbed and the oil film had dissipated to a mere trace on the water surface.

The most common and abundant of these species in the vicinity of Ottawa is *Corethra cinctipes* Coq. It may be found in spring, often in great numbers, in temporary water bodies where *Aedes* larvae abound. We also have found the larvae (May 14, 1927) in a permanent lake on Kettle island, near Ottawa, in shallow water close to the shore. The latter locality was not one in which mosquitoes usually occur, the lake margin at that point being comparatively free from vegetation and floating debris.

The larvae of *C. cinctipes* Coq., develop contemporaneously with larvae of the genus *Aedes*, the adults emerging in early summer. Evidence points to the species overwintering in the egg stage. A jar of water containing immature larvae of *Aedes hirsuteron* Theo., and *A. stimulans* Wlk., and decaying leaves and bottom debris, from a woodland pool, was placed on my office desk on April 19, 1930. On this date no other mosquito life was observed in the water, but a few days later numerous tiny chaoborine larvae developed in the jar. Owing

to the warmth of the office the larvae developed rapidly and several adults of *C. cinctipes* Coq., emerged on May 8. In nature, the adults emerge in late May and June.

The following notes taken in 1930, will illustrate the predacious habits of this species. On May 19, near Gatineau Point, Que., larvae of *Aedes vexans* Mgn., were observed to be particularly abundant in a woodland pool in which *Corethra cinctipes* Coq., larvae also were common. By May 26, there had been a marked reduction in the numbers of *Aedes* larvae, and this could not be accounted for by adult emergences, as very few of the larvae had pupated either in the pool or in our rearing jars. As no other predacious life was conspicuous it was assumed that the reduction of the *Aedes* was due to *Corethra cinctipes* Coq. The following simple experiment supports this assumption. A number of larvae of *C. cinctipes* Coq., were taken from the pool and four were isolated in separate vials and fed partly-grown *A. vexans* Mgn., larvae. Of the *Corethra* larvae, one devoured seven and another nine larvae in a week and pupated June 4, a third ate fifteen in nine days and pupated June 6, and the fourth also destroyed fifteen in nine days, but died on June 8.

Thus, in little more than a week four larvae of *Corethra cinctipes* Coq., destroyed 46 larvae of *Aedes vexans* Mgn., or in other words, the average consumption of each *Corethra* larvae was 1.4 *Aedes* larvae per day. In view of the fact that sometimes *Corethra* are almost as abundant as *Aedes* in the breeding pools, their possibilities for greatly reducing the numbers of the latter need no further emphasis. Unfortunately they are rather indiscriminate cannibals and often devour one another.

In attacking their prey, the *Corethra* seize the victims apparently at any part of the body; head, siphon or abdomen, swallowing them completely within a few seconds. One was observed to seize and devour two larvae in succession within half a minute of each other, the second being swallowed more slowly than the first. One larva caught by the middle, was taken into the gullet, doubled up, the breathing tube and head going in together last.

An allied species with similar habits and life history often found in association with *C. cinctipes* Coq., in the Ottawa district, is *Corethra culiciformis* DeG. Rearings of the two species indicate that the latter is a much less common species. We have reared it from woodland pools containing larvae of various species of *Aedes* and also *Theobaldia morsitans* Theo., adults emerging in late May, June and early July.

In addition to the foregoing, another species of the same sub-family, not hitherto recorded in the district, is *Chaoborus crystallina* DeG. It does not appear to be very common and was first found in a temporary woodland pool near the Rockcliffe aerodrome, on April 30, 1929. In the dark waters of the pool, which also contained small number of *Aedes trichurus* Dyar, and *A. stimulans* Wlk., these elongate, semi-transparant larvae of sinister appearance were practically invisible, their presence first being revealed only on passing a strainer through the water and emptying its contents into a white dish. Several of the larvae were transferred to a small aquarium and supplied with culicine larvae for food. The majority of the larvae of *C. crystallina* DeG., pupated and

emerged between mid-May and mid-June, but two remained in the larval stage until July 19 and one until August 7, on which day it pupated and died.

Larvae of this species also were found on June 7, 1930, in a temporary pool in a field near Westboro. Two of these were reared separately in vials with *Aedes* larvae for food. One of the specimens, did not eat, but pupated June 10, emerging June 13. The other devoured three larvae of *A. vexans* Mgn., between June 7 and 9, but refused larvae after the latter date, pupated June 11, and emerged June 14.

In addition to the above a few *Chaoborus* larvae were collected on October 7, 1930, in the shallow margin of Black lake, a small woodland lake in the Laurentian hills near Kingsmere, Que.

Adults of the allied species *Chaoborus punctipennis* Say, have been taken at Ottawa (July 7 and 24, 1925) but no larvae. Knab (2, p. 169) records finding larvae of this species preying upon larvae of *Culex pipiens* L., in a temporary puddle.

It is well-known that larvae of *Eucorethra underwoodii* Underwood, also a non-biting mosquito, are predacious on other mosquito species. Unfortunately we never have found this species in the Ottawa district, but we have records of it from the Maritime Provinces. In the National Collection there are a number of small bottles containing larvae of *E. underwoodii* Undw., in alcohol, collected by A. D. Foster at St. Stephen and Fredericton, N. B., in 1919. In one of these bottles, labelled from a highland spring at Fredericton, 24. VI. 19, were also several immature *Aedes* larvae. In another vial, larvae taken from a lowland waterhole at Fredericton, 23. VII. 19, included several *Theobaldia impatiens* Wlk. Dyar has noted (1, p.82) that *E. underwoodii* Undw. preys on larvae of the above species in dark permanent forest pools. Dr. W. H. Brittain sent me two larvae of this species taken from a cold spring in Hants county, Nova Scotia, Aug. 3.

Other Predacious Aquatic Insects

Water beetle larvae, dragon fly and damsel fly nymphs, back swimmers and water scorpions, prey on mosquito larvae. Probably by far the most important of these are dytiscid beetle larvae which have voracious appetites and occur abundantly, during the spring and early summer, in temporary pools where mosquito larvae abound. The other predators are more typically denizens of permanent bodies of water which are of less importance in mosquito production, and they do not commonly occur in abundance in the transient waters so frequently pregnant with mosquito life. Under certain conditions, however, they doubtless do much good, as for instance, in mosquito-infested floodwaters of rivers, lakes, ponds, etc., when melting snow, or heavy rains cause them to overflow. Undoubtedly, too, they serve to check the abundance of *Culex* and *Anopheles,* the larvae of which are commonly found in permanent bodies of water.

In the insectary we exposed small numbers of third and fourth instar larvae of *Culex pipiens* L., and *C. territans* Wlk., in shallow dishes of water containing individuals of the predators discussed above, with the following results. A dytiscid beetle larva after killing and feeding upon a larva of its own

species and several damsel fly nymphs, on June 7, devoured 18 out of 20 *Culex* larvae, June 7-13, dying on the latter date. A dragon fly nymph accounted for 29 *Culex* larvae exposed to it, June 9-14, and another ate 28 larvae, June 28-July 9. A damsel fly nymph (*Enallagma* sp.) destroyed all of 50 *Culex* larvae supplied to it, June 13-27, emerging as an adult on June 27. Two back swimmers (*Notonectidae*) disposed of 70 *Culex* larvae, August 1-5, and a water scorpion (*Ranatra* sp.) destroyed 24 out of 30 *Culex* larvae, July 22-31.

It is unfortunate that the attacks of these useful predators are not confined to noxious insect species. The fact is that the promptings of appetite often cause them to destroy their own fellows or members of equally useful, or harmless species. Nevertheless they undoubtedly have a decidedly beneficial effect in reducing the mosquito population.

Of probably merely academic interest is the following instance of a caddis fly larva destroying mosquitoes. The larva, subsequently preserved in alcohol, belongs to the family *Psychomyidae,* of which, according to Lloyd (3), little is known of the life histories of North American species. The larvae of this family are said to live on stones in swift water and also in ponds and lakes "in long, loosely spun galleries of silk and sand grains". One of these silken galleries sheltering an active caddis larva was found on May 13, 1929, attached underwater to the sides of a glass jar containing a collection of *Aedes* larvae taken, on May 2, from woodland pools and ditches in the vicinity of Rockcliffe, Ont. When first noticed, two dead and three living pupae were entrapped in the silken web, and the caddis larva was making swift darting attacks on the latter from the shelter of a tube-shaped gallery to which it was firmly anchored by means of a pair of chitinous hooks which terminate the caudal pair of abdominal prolegs. Later several more pupae and a larva became entrapped and were partially devoured, but the caddis larva died on May 20, following its transfer to a smaller rearing jar.

Amphibia

In 1929, Matheson and Hinman (5) published data showing that the vermilion or red spotted newt, *Triturus viridescens viridescens* Raf., is predacious on mosquito larvae. We have been unable to find this species in mosquito pools in the Ottawa district, but according to Mr. Clyde L. Patch, Chief Herpetologist of the National Museum of Canada, the species occurs in southern Ontario, and also in southern Quebec and the Maritime Provinces, where it usually inhabits small lakes and ponds.

Larvae of another species, kindly identified by Mr. Patch as the yellow-lined salamander, *Eurycea bislineata bislineata* Green, were found at several points in the Ottawa district in temporary pools both in open fields and in woodland. The salamanders were first found by Mr. G. H. Fisk, on June 5, 1930, in shallow pools in a meadow near Westboro. The pools were of the type in which larvae of *Aedes fitchii* F. & Y., and *A. excrucians* Wlk., commonly develop, but none were present on the above date. Several of the salamanders were taken from a pool and placed in the insectary in trays containing water. They were then fed with larvae of *Aedes vexans* Mgn., which they swallowed readily. Afterwards they were supplied solely with *Culex* larvae and were maintained on this diet until the end of July, a period of nearly two months.

Four immature salamanders that were placed separately in saucers and supplied with larvae of *Culex pipiens* L. and *C. territans* Wlk., at intervals of one or two days, devoured 614 between June 9 and July 2. The largest number of *Culex* eaten by any one salamander during this period was 173 and the smallest 137. The average daily consumption of each was seven.

This species of salamander was also found in sandy and rock bottomed temporary to semi-permanent pools, containing much aquatic vegetation and small animal life, near Hogs Back and in Riverside Park, in the Ottawa district. Larvae of this species of salamander were also taken on October 7, in small woodland pools that formed part of the stony bed of a dried-up stream that has its course down the side of Kings Mountain, near Kingsmere, Que.

Mr. Patch gives the distribution of this species in Canada as New Brunswick, the Gaspe peninsula, Que., southern Quebec and southern Ontario.

Fish

No direct observations on the part played by fish in destroying mosquito larvae have been made by the writer other than to frequently note that in water bodies where fish occur, mosquito life is usually scarce or absent, although, as pointed out elsewhere, factors other than the presence of predacious life may be responsible for this. It has been noted, however, that in natural waters where fish and other predators have been destroyed by pollution, *Culex pipiens* L., often develops in quite astonishing abundance. In many parts of the world fish are regarded as among the most important of the natural enemies of mosquitoes, but in Canada their field of usefulness is greatly restricted by the fact that most of our pest species are confined to temporary water bodies in which fish are unable to exist. Under some circumstances fish probably effect a measure of control on mosquitoes developing in river floodwaters, although in the Ottawa district, at least, their activities have not been sufficient to prevent outbreaks of serious intensity from developing.

Hydras

The tiny aquatic animals known as hydras kill and devour mosquito larvae. Our observations on these animals came about as follows. Three wooden buckets containing water and vegetable matter were retained close to the insectary, and eggs and larvae of *Culex* were occasionally introduced, originally with the object of maintaining a convenient supply of these insects for laboratory purposes. In one of the buckets, *Utricularia macrorhiza* LeC., introduced from a local ditch, effectively prevented mosquito development, but, in the other two, *Culex* larvae were plentiful until early in July, when Mr. Fisk noticed that in one of them mosquito life had suddenly and unaccountably disappeared. On observing closely, Mr. Fisk detected the presence of large numbers of hydras attached to submerged stems, leaves and grasses in the water. He placed a number of these in a saucer of water with *Culex* larvae and found that the hydras readily killed and swallowed first, second and third instar larvae, the prey being completely engulfed in from ten to twenty minutes. The larvae were paralyzed merely by contact with the tentacles, and many more were destroyed in this manner than were required by the hydras for food. Specimens submitted to Mr. Douglas Leechman, of the National Museum, were kindly identified as *Hydra vulgaris* Pallas. It is believed probable that the species was introduced into the bucket on some *Lemna trisulca* L.

Hydras are fresh-water hydrozoans belonging to the phyllum Coelenterata. Their bodies consist largely of a stomach and mouth, the latter being surrounded by a circle of tentacles armed with nematocysts or stinging cells with which living organisms are captured for food. The hydras attach themselves to submerged vegetation by means of a disc-like foot and extend the body into the form of a slender stalk, from the end of which the tentacles are moved about in search of prey. When alarmed the tentacles and body are retracted, the latter becoming globular in form.

In the bucket where first observed, the hydras continued to destroy mosquito larvae throughout July. Young *Culex* larvae that appeared on July 10, from egg rafts introduced on July 8, all disappeared by the following day. On July 16, 22 and 28, egg rafts and numerous larvae transferred from a nearby barrel, disappeared in each case within a day or two of introduction. Early in August it was found that the hydras were no longer present in the bucket, apparently having died from some unknown cause. After this, introduced mosquito larvae developed unharmed.

According to Mr. Leachman, two other species of hydras, *Hydra fusca* L., and *H. viridis* L., also occur in the Ottawa district, in water bodies such as ponds and lakes.

Protozoa

Protozoa (and algae) are quite frequently found attached to mosquito larvae, sometimes so abundantly as to almost completely cover the insect, including even the eyes and gills. Among these organisms, colonies of stalked Infusoria such as *Vorticella* are conspicuous, when very numerous appearing to the unaided eye as a coating of jelly on the larvae. These are found most frequently in open sunlit pools on larvae of such species as *Aedes trichurus* Dyar, *A. stimulans* Wlk., and *A. fitchii* F. & Y. We have no reason to believe that the presence of these organisms is in any way harmful to the larvae.

AQUATIC PLANT ENEMIES OF MOSQUITOES

During 1930, a careful survey of water bodies in the Ottawa district was conducted to find out which of the plant species reported as inimical to mosquito life occur here. In this connection thanks are due to Messrs. H. Groh and J. Adams, Botanists of the Division of Botany, Central Experimental Farm, and to Dr. M. O. Malte, Botanist of the National Museum, for the assistance they gave in the identification of several of the aquatic plants discussed hereafter.

Stoneworts

Stoneworts are fresh water algae of the family Characeae which have been reported deleterious to mosquito life. In the Ottawa district, stoneworts were found in McKay lake, Rockcliffe, Ont., and in Fairy lake, near Hull, Que. They were not found in temporary water bodies, or elsewhere in the district.

Dr. Marshall A. Howe, Assistant Director of the New York Botanical Garden, to whom specimens were sent, stated in a letter dated October 20, 1930, that, "I feel rather confident that the one from McKay lake, July 23, 1930, is a form of the widely distributed *Chara fragilis* Desv. The other, from Fairy lake, is sterile, but I take it to be a species of *Nitella*." Specimens from both lakes also were sent to Mr. James Groves, Freshwater Bay, Isle of Wight, Eng-

land, who reports the McKay lake species as *Chara fragilis* subspecies *delicatula* Braun, and the specimens from Fairly lake as *C. fragilis* Desv., and a sterile *Nitella,* probably *N. opaca.*

McKay and Fairy lakes are small permanent lakes situated at the bottom of wooded hollows. As is usual with this type of water body, belts of emergent vegetation, with cat-tails predominating, grow in the shallow margins. The *Chara* and *Nitella* taken from Fairy lake occurred in the shallow water, apparently at only one point, and were not abundant. With the single exception of an *Anopheles* larva, no mosquitoes were found breeding in this lake. In McKay lake, *Chara fragilis* Desv., was quite prolific and growing vigorously among the cat-tails at the northern end, which has a marl bottom. Other interesting aquatic plants found here were hornworts, *Ceratophyllum demersum* L.; spiked water milfoil, *Myriophyllum spicatum* L.; water weed, *Elodea (Philotria) canadensis* (Michx.) Britton; the bladderworts, *Utricularia macrorhiza* LeC., and *U. minor* L.; the duckweeds *Lemna minor* L., *L. trisulca* L., and *Spirodela polyrhiza* (L.) Schleid., and the tiny floating plant, *Wolffia* sp. These are recorded specifically as several, at least, are considered to be of value in controlling mosquitoes.

At only one point in McKay lake were mosquito larvae found (July 3). This was in an open space a few square yards in area, among the cat-tails close to the shore. At this point in the shallow water within eight feet of the lake margin, *Chara fragilis* Desv., was growing. There was also a plentiful growth of water weed, duckweeds and bladderworts. Larvae in all stages, as well as pupae, of *Culex apicalis* Adams and *Anopheles walkeri* Theo., were quite abundant and continued to be so throughout July and August. The finding of mosquito larvae developing normally in water where *Chara fragilis* Desv., was growing occasioned surprise in view of the published results of investigations by Matheson and Hinman (4, 6 & 7) which indicate that this plant is toxic to mosquito life. To check up on the matter we selected another point some distance away, where, a few yards from the lake margin, among the cat-tails, a very luxuriant growth of *Chara fragilis* Desv., and *Elodea canadensis* occurred, but no mosquito larvae could be found.

At this point, on July 22, three cylindrical cages, eight inches in diameter and a foot high, constructed of bronze wire screen, twenty meshes to the inch, were placed in the water with their bottoms resting directly on living vigorous plants of *Chara fragilis,* six to eight inches from the surface. Approximately 200 larvae of *Culex pipiens* L., and *C. territans* Wlk., from a water-barrel, were placed in each cage. The majority of the larvae were in the second and third instars, but first and fourth instar larvae also were present. Some of the smallest larvae made their escape through the screen mesh, but the latter was fine enough to retain the great majority. The tops of the cages were covered with cheesecloth to prevent the escape of emerging adults. Emergences commenced on July 24, and continued almost daily until August 5, when no larvae or pupae remained. A few days previously a number of dead larvae were seen on the cage bottoms. but were evidently disposed of by minute water life. From the three cages, July 22—August 5, 280 adults emerged, representing nearly 50 per cent. of the larvae originally introduced

It is apparent from these observations that, under certain conditions at least, *Chara fragilis* Desv., cannot be relied upon to give satisfactory mosquito control. Were this not so, it is highly improbable that *Chara* could prove of any importance in mosquito control in Canada, as it evidently thrives only in a limited and specific environment, and probably could not be induced to grow in the temporary waters which form the most prolific source of our pest species. Needham and Lloyd (8, p. 139) state that, "The stoneworts, unlike many other algae, are wonderfully constant in their localities and distribution.....They cover the same hard bottoms with the same sort of gray-green meadows, year after year.....". I would also recall that early in May, 1928, Prof. Robt. Matheson, on request, kindly shipped a quantity of living *Chara fragilis* from Ithaca, N. Y., to Ottawa, and an attempt was made to establish the plants in several more or less sunlit temporary pools where mosquito larvae were abundant. The *Chara* had no apparent effect on the larvae, but shortly commenced to die and decay, and completely failed to establish itself.

Canadian Water Weed

The Canadian water weed, *Elodea* (*Philotria*) *canadensis* (Michx.) Britton, is a fairly common aquatic plant in the Ottawa district. Matheson (4, p.81) found that *Culex* larvae placed in aquaria containing this plant nearly all died without producing adults, and that adults refrained from ovipositing in the aquaria. As recorded in the preceding section, *Elodea canadensis* was found growing in abundance in a portion of McKay lake infested with *Culex apicalis* and *Anopheles walkeri*, without apparent ill effects to these species. It was also found growing luxuriantly in a shallow *Typha*-grown pool close to McKay lake in which, on July 30, *Anopheles* larvae were present in considerable numbers. Portions of *Elodea canadensis* without roots, were used to embellish a small aquarium containing larvae of *Culex pipiens* L., on display for two weeks in August and September, in the Canadian National Exhibition, at Toronto. The larvae apparently were not affected by the presence of the plant, many completing their life cycle and emerging as adults.

Bladderworts

There are several species of bladderworts of the genus *Utricularia*, occuring in the Ottawa district, in the shallow waters of lakes, ponds and ditches. These plants capture small aquatic animals by means of traps or bladders attached to their finely dissected leaves. During our survey three species of bladderworts were found, namely, *Utricularia macrorhiza* LeC., *U. intermedia* Hayne and *U. minor* L.

Larvae of *Culex apicalis* Adams, *Anopheles maculipennis* Mgn., *A. punctipennis* Say, and *A. walkeri* Theo., occurred in several of the water bodies where the bladderworts were growing. The species *Utricularia macrorhiza* LeC., owing to the number and size of its bladder-traps, appears to be the most important as an actual or potential factor in mosquito control. This species was observed blossoming in mid-July, the pretty yellow, bilabiate flowers being borne on slender stalks above the surface of the water.

Both *Utricularia macrorhiza* LeC., and *U. intermedia* Hayne, readily trap mosquito larvae in all stages, and also pupae, but *U. minor* L., owing to the small size of its bladder-traps, is able to capture only small, immature larvae.

The results of the following experiments, using larvae of *Culex pipiens* L., and *C. territans* Wlk., from a rainwater barrel, illustrate this.

On June 14, twenty larvae, several of which subsequently pupated, and two pupae, were placed by Mr. Fisk in a jar of water containing *Utricularia macrorhiza* LeC. By June 19, seventeen larvae and three pupae had been captured in the traps and only two adults emerged. One of the traps contained two larvae and another a small snail. On July 16, twenty immature larvae released in another jar containing the same species of bladderwort, were all trapped by the following day.

Twenty *Culex* larvae were placed in a jar containing *Utricularia intermedia* Hayne, on July 16. The following day all but three were entrapped by the plant. Of these, one was subsequently captured and two pupated, one adult emerging on July 22.

Twenty *Culex* larvae were placed with *Utricularia minor* L., in a jar on July 22. Of these the tiny traps succeeded in capturing only two of the smallest larvae, the balance surviving, probably owing to their larger size.

Early in June, some *Utricularia macrorhiza* LeC., was placed in a wooden bucket outside the insectary. The plant shed its bladder-traps late in June, and *Culex* larvae then began to appear in the water. The bladders were soon replaced by new growth and all the larvae and pupae disappeared by July 11. Subsequently *Culex* egg-rafts and larvae were placed in the bucket periodically until August 15, but the larvae invariably quickly disappeared. In another bucket of water close at hand containing only organic matter and decaying leaves, *Culex* larvae developed in abundance throughout the summer.

Free-floating Surface Plants

The suggestion often has been advanced that plants of the duckweed family may serve to prevent mosquito-breeding by completely covering the surface of water bodies in which these insects develop. Our own experience has been that although certain species of this family are quite common, notably *Lemna minor* L., *L. trisulca* L., *Spirodela polyrhiza* (L.) Schleid., and *Wolffia* sp., they seldom are sufficiently abundant to form a mat over the surface of the water complete enough to prevent mosquitoes from breeding, particularly in temporary bodies of water where effective control is most desired. Their value as an aid to mosquito control in Canada consequently may be said to be negligible. Indeed, it seems probable that these tiny plants with their submerged rootlets may even serve to shelter mosquito larvae from some of their free-moving enemies.

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THE BICOLOR GROUP OF THE GENUS EPHEMERELLA WITH PARTICULAR REFERENCE TO THE NYMPHAL STAGES* (EPHEMEROPTERA)

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(Continued from page 42)

The following four species are very closely allied and in the adults possess no very definite characters for specific distinction, even the male genitalia failing in this respect. This leads me to believe that we are dealing with a group the individuals of which have split away either from each other or from a parent form at a comparatively recent date and that even now fresh species may be in the act of formation. The nymphs offer much better specific characters and, once recognized, are not readily confused; long series of bred material may result in the discovery of good adult characters but for the present I am basing my conception of the different species largely on nymphal distinctions.

Ephemerella bicolor Clem.

Pl. 2, figs. 13-15; Pl. 3, figs. 6, 6a; Pl. 4, fig. 7; Pl. 5, fig. 14

Ephemerella bicolor Clemens, 1913, Can. Ent. XLV, 336, Pl. VI, fig. 3; id. 1915, Cont. Can. Biol. 123, Pl. XIV, fig. 1; McDunnough, 1925, Trans. Roy. Soc. Can. (3) XIX, Sec. V, 212; id. 1930, Can. Ent. LXII, 57, Pl. VIII, fig. 5.

The identity of this species has been definitely established by an examination of Clemens' adult types, including the nymphal skins, and also a long series of nymphs collected by Clemens in the Go Home Bay region.

Based on our bred material *bicolor* would appear to be rather a paler-colored species than the other members of the group; in the male the brown of the abdominal tergites has a distinct olivaceous tinge whilst the sternites are pale with only slight brownish tinges on the anterior ones; apart from some black streaks near the lateral flange there is normally little maculation but some specimens (possibly those from nymphs with pale dorsal stripe) show a palish dorsal stripe which is usually bordered with fine, broken, dark, subdorsal lines and cut by a similar-colored median one. The legs are rather pale yellow with black spots on the brown-tinged coxae; there may be traces of slightly ruddy tinges at the apex of the femora but never definite dark spots. In the female the head is pale yellow with variable blackish shades or patches on the vertex on each side of a slight median ridge; between this black shading and the eyes is usually some brown coloration which at times extends forward to the rear of the ocelli.

The species occurs during the latter part of June and early July; in 1930. in which year the spring was earlier than usual, specimens began to appear in our cages as early as June 12.

As pointed out by Clemens the nymph is very variable in coloration, the pale specimens with black or brown bandings on the thorax and posterior segments of the abdomen presenting quite a striking appearance. The size also varies markedly in various sections of the country; Georgian Bay nymphs (Clemens' type material) when full-grown average between 6 and 7 mm.; those from the St. Lawrence river in the Lachine-Vaudreuil region are much larger, nearly 8 mm. long and correspondingly broader; at Brome Lake, Knowlton, the size at maturity is only slightly larger than that of Georgian Bay specimens whilst in the Mississquoi river at South Bolton we found very small nymphs plentifully which did not exceed 6 mm. in length at the time of emergence. There was nothing in the structural characters of all these which would indicate a specific difference. The head is without occipital tubercles in the male, although frequently there are faint indications of these in the female. The two rows of dorsal abdominal tubercles are strongly divergent from front to rear, *a rather abrupt increase in width between the individual tubercles occurring on segment V;* on this and on the two following segments the width between the tubercles is about equal to the length of the respective tergite in the median line but there is a certain amount of individual variation and in some specimens this width is scarcely that of the length of the segment. The tubercles of segments I-III are rather short, chunky and hardly tapering, on II and III being about half as long as the distance between them; on the gill-bearing segments the tubercles are somewhat shorter, flatter, more pointed and spine-like. The postero-lateral spines on segments II and III are very weakly developed, that of I being merely a slight angle in the lateral contour; on the posterior segments the spines are well-developed, curving gracefully backward and tipped with black, their outer edge furnished with short spinules interspersed with longer hairs. Segment VIII at its greatest width is about four times as wide as its length on the mid-dorsal line (23:6). On the operculum the hinge-line is generally outlined in pale color and there is frequently an oval patch in the middle. Ventrally the curved row of four black dots is normally (but not constantly) present as are also the short lateral dashes. The setae show indications of pale banding but not nearly so noticeably as in *aestiva*; the legs on the other hand, appear more distinctly banded, the femora being pale yellowish, crossed by two brown bands which are sparsely dotted with pale color, and the tarsal joint showing a very prominent dark band.

MATERIAL EXAMINED. *Adults*:- Clemens' types from Georgian Bay region, Ont.; bred adults from Lachine and Vaudreuil, Que. and long series of captured specimens from the St. Lawrence valley region (Prescott, Vaudreuil, St. Anne's, Beauharnois, Lachine, Laprairie, St. Lambert); bred adults from Brome Lake, Knowlton, Que. and Mississquoi river, South Bolton, Que.; a small series from the vicinity of Wakefield, Que. including one bred ♂ from the Lapeche river; a few odd specimens from the Ottawa region, none bred; a few doubtful specimens from Boiestown and Fredericton, N. B. *Nymphs*:- Clemens' collection from the Georgian Bay region; long series from the Lachine and Knowlton regions and a few specimens from the Lapeche river, Wakefield, Que.

Ephemerella minimella n. sp.

Pl. 2, figs. 11, 12; Pl. 4, fig. 5; Pl. 5, fig. 4

Male (in alcohol). Eyes orange; head between the eyes yellow with brown shading around the ocelli; thorax dorsally deep brown, shaded with yellowish laterally and in the sutures; abdomen dorsally deep brown on segments I-VII, shaded with paler color on VIII-X; slight smoky shading subdorsally on I-IV; a fine brown dorsal line and a pair of blackish subdorsal dots on the anterior margins of segments, becoming fainter on VII-X; on segments VIII and IX fine subdorsal lines coalesce with the dorsal line on posterior portion of segments; short, oblique black streaks and longer longitudinal black lines occur just above the lateral flange, most distinct on anterior segments. Ventrally the thoracic sternites are rather bright brown, the abdominal ones pale brown shading into light creamy on the last two segments; a curved row of four minute dots distinctly visible on segments II-VII. Forceps pale; setae pale, ringed at joints with blackish. Legs rather bright yellow with a black spot on each brown-tinted coxa and *a distinct brown spot at apex of each femur.* Length of body 6 mm.; of fore-wing 6 mm.

Holotype—♂, Knowlton, Que., July 7, 1930; bred from nymph taken in Knowlton Creek by L. J. Milne; No. 3216 in the Canadian National Collection, Ottawa.

As compared with alcohol specimens of *bicolor,* bred from Brome Lake and Lachine nymphs, the brown of thorax and abdomen is deeper, and the yellow of the legs is brighter. Our *bicolor* specimens show further scarcely any traces of the dorsal line and subdorsal spots of *minimella,* nor is there more than a trace of the apical brown femoral spot; whether, however, these are specific or merely individual characters can only be determined by further breeding. A *verisimilis* male in alcohol, bred from a nymph from the Yamaska river at Foster Power Plant, shows the subdorsal dark dots of *minimella* but lacks the middorsal line and the thorax is much paler in color.

The male nymph (according to the nymphal skin from which the holotype emerged) is very similar to a small *bicolor,* agreeing in the entire lack of occipital tubercles. The lateral prolongations of the abdominal segments are also similar, especially those of II and III which are very weak; the lateral edges of VIII and IX are, however, less convex and more subparallel than is the case in *bicolor.* In the dorsal abdominal tubercles is found the best point of distinction; these are much longer, thinner and more upright, especially those of segments V-VII, which are fully twice the length of those of the same segments in *bicolor;* the two rows diverge very evenly without an abrupt broadening on segment V and segments VIII and IX show also short spines. The width between the tubercles of segments V-VII is rather less than the median length of the respective segments. The setae are unbanded. Length, 6 mm.

A small series of nine nearly mature nymphs taken in the Missisquoi river at South Bolton on June 30 and July 10 appears to agree with the above nymphal skin, in these the dorsal tubercles being even longer and thinner than in the Knowlton Creek specimen. The female nymphs show slight traces of occipital tubercles, much as in *bicolor.* The femora are dark with four or five isolated yellowish spots, which sometimes coalesce to form a partial band. A

few pinned adults, taken near Sweetsburg, Que. (Knowlton region) on July 8 and 15 and a small series from Burk's Falls, Ont. (July 9-14) may belong here but it is impossible to compare dried specimens with alcoholic material with any degree of accuracy and the matter must be left until pinned bred specimens are available for study; these specimens can hardly be placed in *bicolor* on account of the darker ventral abdominal surface.

Ephemerella aestiva n. sp.

Pl. 2, fig. 10; Pl. 3, figs. 5, 5a; Pl. 4, fig. 6; Pl. 5, figs. 6, 13.

Male. Hardly to be distinguished from large *bicolor*; the color of the thorax is a slightly deeper brown than in *bicolor*; the first seven abdominal tergites are rather evenly deep brown and the last three bright brown; a somewhat paler dorsal stripe, cut by a fine brown median line and bordered by similar darker lines, is present in the holotype but obscure in some of the paratypes. Ventrally segments I-VII semihyaline, the first three tinged with brown; segments VIII and IX opaque whitish, shaded with light brown; curved row of four dark dots, faint in holotype, better defined in some paratypes. Forceps pale. Setae banded with ruddy-brown at incisions. Legs light yellow with a dark spot laterally on coxae; mid and hind femora with traces of darker shading in median area and a slight dark streak terminally. The genitalia are scarcely distinct from those of *verisimilis*. Length of body 6 mm.; of forewing 6 mm.

Female. Head pale yellow, with the central portion of the vertex obscured with blackish shades between which and the eyes is some rather ruddy-brown shading. Thorax and abdomen dorsally deep brown. Ventrally the abdominal segments (as far as can be determined) are paler, segment VIII is largely a rather bright brown and segment IX is pale whitish centrally, with the lateral and posterior portions, including the subanal plate, a bright brown; the black dots of the male sex are not very evident (except in one specimen). Size similar to that of male.

Holotype—♂, Vaudreuil, Que., July 12, (G. S. Walley) (bred from nymph 153); No. 3213 in the Canadian National Collection, Ottawa.

Allotype—♀, same data (bred from nymph 254).

Paratypes—8 ♂, Vaudreuil, Que., July 6, 9, 10, 12; 1 ♀, Vaudreuil, Que., July 9; 1 ♀, Lachine, Que., July 22; 3 ♀, Foster Power Plant, Knowlton region, Que., Aug. 6, 12, all bred.

I am unable to offer any satisfactory characters whereby the adults may be separated from those of *bicolor*; the nymphs of the two species are, however, quite easily separable and for this reason I am convinced the species is a good one. Material with no definite nymphal associations must, for the present, remain only doubtfully determinable.

The nymph is rather small, averaging about 7 mm. in length. The general color is dark brown, slightly sprinkled with pale dots; there are generally traces at least of a paler median abdominal stripe, bordered by darker shades and cut by a median dark line. The legs are dark brown and the pale banding on the femora is reduced, especially on the two hind pair, to small oval spots, interspersed with sparse pale dots. The femora themselves are shorter and chunkier than in any of the allied species, the length of the ventral edge of the

hind femur being slightly more than twice the greatest width of the femur (16:7); this character, once recognized, is easily the best means of separating the species from *bicolor* and *verisimilis*. The occipital tubercles are present in both sexes and moderately prominent. The two rows of dorsal abdominal tubercles are subparallel; there is some slight variation in the distance between the individual tubercles of each pair but in general those of segments I-III are noticeably wider apart than in *bicolor* whilst those of the gill-bearing segments are scarcely as wide apart as the median length of the tergite. The tubercles themselves are moderately long, rather narrow and bluntly tapering on the first three segments, becoming, as usual, flatter and more acuminate on segments IV-VII. With respect to the lateral prolongations of the abdominal segments, the spines of II and III are somewhat stronger than in *bicolor* and those of the posterior segments, especially VIII and IX, are more produced and not so gracefully curved inward as in this species and *verisimilis;* the lateral edges of the prolongations are well furnished with spinules to the almost entire exclusion of the longer hairs predominating in *bicolor*. The operculum is well sprinkled with pale dots and shows a small oval pale patch in the middle; the joint is at times faintly defined by a pale line. Ventrally the curved median row of four black dots and the short lateral dashes are generally distinct; the two central dots of the row, however, show a tendency to become obsolescent. The setae are deep brown with alternate pale yellow bands.

We first met with the nymphs in 1929 when a few rather immature specimens were secured from the Mid Yamaska river at the Foster Power Plant in early July; later (July 24) a small series of more mature nymphs was dredged from the Massawippi river at North Hatley. At the time we supposed them to be slightly variant *bicolor* and it was only after a more careful study on returning to Ottawa that the distinctness of the species became evident. In 1930 the nymphs were found plentifully at Vaudreuil, Que., below the railway bridge, in late June and early July and the type series of adults was bred from this material and from a few specimens secured in the Yamaska river, where, however, it was quite rare. The nymph matures later in the season than any of the allied species and it is worthy of note that on June 25 at Vaudreuil—where a large race of *bicolor* also occurs—nymphs of this latter species were quite mature, whereas those of *aestiva* were still young and certainly not in their final instar; on July 4 when *aestiva* nymphs were reaching maturity, no *bicolor* nymphs at all could be found; there is probably a two-weeks difference, roughly speaking, between the times of emergence of these two species and in view of the extreme similarity of the adults the date of capture will undoubtedly prove an important factor in determining the species. In the Knowlton district the species appears even later than at Vaudreuil and apparently is not on the wing until August long after even the stragglers of *bicolor* have disappeared.

Ephemerella verisimilis McD.

Pl. 2, figs. 8, 9; Pl. 3. figs. 7, 7a; Pl. 4, fig. 8; Pl. 5, fig. 15.

Ephemerella verisimilis McDunnough, 1930, Can. Ent. LXII, 57, Pl. VIII, fig. 4.

In 1930 Mr. W. J. Brown succeeded in breeding several specimens from the nymph at Bradore and definitely established the association I tentatively made at the time of description; nymphs were also found at Thunder River, Que., considerably west of the type locality.

As noted in the original description the dark color of the abdomen, particularly the ventral surface, and the deep yellow of the legs should separate the species from *bicolor* and *aestiva*.

The typical nymph from the Bradore region, while close to that of *bicolor*, is not really hard to separate. The size is larger than even that of the large Lachine form of *bicolor*, averaging well above 8 mm. in length with occasional females attaining 9 mm. The head tubercles are present in both sexes and quite well-developed. The two rows of dorsal tubercles are slightly wider apart on the anterior segments than in *bicolor*, diverging very gradually and evenly towards the rear without the sudden increase in width found on segment V of this latter species; the distance between the tubercles of segments V-VII is generally slightly less than the median length of the respective tergite although specimens occur in which the lengths are equal. The tubercles themselves are somewhat longer than in *bicolor*, especially those of the posterior segments; they are also more erect, with distinctly more pointed apices. The lateral spines of segment II and especially segment III are better developed whilst on the other segments these prolongations are much as in *bicolor*. The width of segment VIII at its widest point as compared to its length in the median line is as 10:3. The setae show absolutely no tendency toward pale banding. In the legs the dark banding of the femora has been much reduced in Bradore specimens but in the small series from Thunder River (which includes specimens even larger than those from Bradore) the darker bands are more evident and much as in *bicolor*.

Small series of nymphs taken in June in various small streams of the Knowlton region have proved very puzzling. The first lot was taken in Knowlton Creek about three miles south-east of town on June 21, 1929 but none were bred; these nymphs, (figs. 8, 9) whilst differing from *bicolor* and agreeing with *verisimilis* in the length of the lateral abdominal prolongation of segments II and III and the length and arrangement of the dorsal abdominal tubercles, are smaller (7 mm.) than typical *verisimilis* and have the occipital tubercles practically lacking in the males and reduced in the females. In 1930 a series of 5 males, 4 females was bred between June 11-20 from very similar nymphs from the Bolton Pass Creek; in these nymphs, however, the occipital tubercles were better developed, being at least indicated and frequently quite strong in the males as well as in the females; an odd male was also bred on July 4 from a similar nymph from the Mississquoi river at South Bolton. In the Mid Yamaska river, at Foster Power Plant, six miles north of Knowlton, mature nymphs were found on June 11 and a series of 4 males bred between June 13-19; in these nymphs the occipital tubercles are at least indicated in both sexes but the dorsal tubercles of segments I-IV are somewhat shorter and blunter than in the preceding lot and also consequently than in typical *verisimilis*. Finally 3 large, mature specimens (1 male, 2 females) were sorted out of collections made at Knowlton Creek near the railway bridge on June 7; these agree with the Bolton Pass series. The adults resulting from the above-mentioned breedings approach in the darker colors of the abdomen (notably the ventral surfaces), legs and and female head (where this sex is definitely known), *verisimilis* rather than *bicolor*, although typical Bradore specimens are larger and still deeper in color than our Knowlton ones; the male genitalia, while not precisely similar, also bear

out this association. As the range of *funeralis* has been found to extend northward as far as Thunder River there seems no valid reason why both species should not occur around Knowlton and for the present I prefer to treat the Knowlton specimens as slight variations of *verisimilis* rather than as a new species.

MATERIAL EXAMINED. *Adults*:- Type series and numerous other specimens from Bradore, Que. collected in 1929 and 1930 by W. J. Brown and including bred material; 2 ♀, Trinity Bay, Que.; a small bred series from the Knowlton region as indicated above; also 5 ♂, (pinned) and 6 ♂ in alcohol, collected in Bolton Pass swarming at dusk (June 15) and several females from the Foster region; 1 ♂, Covey Hill, Que. (Allotype of *funeralis*) odd females from the Algonquin Park region, Ottawa and St. Lawrence districts, and a pair from Boiestown, N. B. All captured material placed here provisionally on account of the dark ventral surface of the abdomen. *Nymphs*:- Long series from Bradore Bay and Thunder River, Que.; series from the Knowlton region as noted above.

EXPLANATION OF PLATES

PLATE 2

1. Nymph of *Ephemerella temporalis* McD. ♀, Brome Lake, Que.
2. " " " " " ♀, (striped form), Brome Lake, Que.
3. " " " *lutulenta* Clem. ♂, (striped form), Georgian Bay.
4. " " " " " ♀, Georgian Bay.
5. " " " *funeralis* McD. ♀, Knowlton district.
6. " " " *coxalis* McD. ?, ♀, Rideau River, Ottawa, Ont.
7. " " " *prudentalis* McD. ♀, Brome Lake, Que.
8. " " " *verisimilis* McD. ♂, Knowlton Creek, Knowlton, Que.
9. " " " " " ♀, " " " " "
10. " " " *aestiva* McD. ♂, Yamaska River, Foster, Que.
11. " " " *minimella* McD. ♂, Mississquoi River, Foster, Que.
12. " " " " " ♀, " " " " "
13. " " " *bicolor* Clem. ♂, (small form), Mississquoi River, S. Bolton, Que.
14. " " " *bicolor* Clem. ♀, " " " " " " Que.
15. " " " *bicolor* Clem. ♀, (large form), Lachine, Que.

All enlarged to about three and a half times the actual length.

PLATE 3

1. Head of nymph of *Ephemerella lutulenta* Clem.
2. " " " " " *temporalis* McD.
3. " " " " " *funeralis* McD.
4. " " " " " *prudentalis* McD.
5. " " " " " *aestiva* McD.

5a. Right hind leg of nymph of *Ephemerella aestiva* McD.
6. Head of nymph of *Ephemerella bicolor* Clem.
6a. Right hind leg of nymph of *Ephemerella bicolor* Clem.
7. Head of nymph of *Ephemerella verisimilis* McD.
7a. Right hind leg of nymph of *Ephemerella verisimilis* McD.

PLATE 4

1. Abdominal segments I, II and VII of nymph of *Ephemerella lutulenta* Clem.
2. " " " " " " " " " " " *temporalis* McD.
3. " " " " " " " " " " " *prudentalis* McD.
4. " " " " " " " " " " " *funeralis* McD.
5. " " " " " " " " " " " *minimella* McD.
6. " " " " " " " " " " " *aestiva* McD.
7. " " " " " " " " " " " *bicolor* Clem.
8. " " " " " " " " " " " *verisimilis* McD.

PLATE 5

1. Male genitalia of *Ephemerella coxalis* McD. (Dorval, Que.)
2. " " " " *prudentalis* McD. (Knowlton, Que.)
3. " " " " " " (lateral view)

4. " " " " *minimella* McD. (Holotype)
5. " " " " *verisimilis* McD. (Bolton Pass, Que.)
6. " " " " *aestiva* McD. (Paratype)
7. " " " " *lutulenta* Clem. (Orillia, Ont.)
8. Female subanal plate of *Ephemerella lutulenta* Clem. (Gauvreau Lake, Que.)
9. " " " " " *temporalis* McD. (Brome Lake, Que.)
10. " " " " " *funeralis* McD. (Covey Hill, Que.)
11. " " " " " *coxalis* McD. (Vaudreuil, Que.)
12. " " " " " *prudentalis* McD. (Knowlton, Que.)
13. " " " " " *aestiva* McD. (Lachine, Que.) (Paratype)
14. " " " " " *bicolor* Clem. (Lachine, Que.)
15. " " " " " *verisimilis* McD. (Bradore Bay, Que.)

THE NEARCTIC SPECIES OF THE NEMESTRINID GENUS RHYNCHOCEPHALUS FISCHER, (DIPTERA).

BY C. H. CURRAN.

Am. Museum of Nat. History, New York.

In 1908 Professor T. D. A. Cockerell, (Trans. Am. Ent. Soc., xxxiv, 247-254) reviewed the American species of the Family Nemestrinidae occurring North of Mexico, including the fossil forms, and in that paper three species of the genus *Rhynchocephalus* were considered. During the summer of 1922 the author captured a number of specimens of a species of Nemestrinidae while on a collecting trip at Baldwin Hill, about 12 miles from Lawrence, Kansas. A comparison of the specimens with the species represented in the Kansas University Museum and with the descriptions of all the species of which the author is aware, revealed the fact that the species is apparently undescribed. In addition a few specimens of this species; together with about twenty of a second apparently undescribed species were found among the undetermined Diptera of the Museum Collection. Three specimens in the collection which had been determined as *R. sackeni* Williston in this collection are quite evidently *R. subnitens* Cockerell although they are larger than the type of that species.

Both the new species belong to the *volaticus* group and are evidently closely related to each other. They present characters which render their identification moderately easy although the series display considerable variation.

I am able, because of the excellent series obtained, to reach some conclusions regarding the taxonomic value of certain characters. The length of the proboscis has been considered of importance in distinguishing the species but I find this character of practically no value, as in two females, otherwise identical, the proboscis reaches, in one, only to the anterior coxae while in the other it reaches the apex of the second ventral segment; all intermediate lengths occur and the length seems to depend upon whether it is drawn in or more or less extended. The amount of curvature of the lamellae of the ovipositor also varies in otherwise identical specimens and this seems to depend to a certain extent upon dessication. However, the character of the ovipositor is more dependable than that of the proboscis as the end may be more or less broadened. The color of the abdomen is found to be variable, and it is always darker in the female. In the specimens studied the wing venation is much more constant than would seem to have been found by Professor Cockerell. The color of the pile seems to be fairly constant, within a certain range, but may intergrade between species. The lengths of the segments of the antennal style seem to vary and while this character is of some value it would appear that it

is not safe to place too much reliance upon it. It is evidently of more value in separating the two groups but these are readily separated by the wing venation, general shape, etc.

SYNOPSIS OF THE SPECIES OF RHYNCHOCEPHALUS.

1. Second posterior cell closed .....2.
   Second posterior cell open .....3.
2. Posterior femora and tarsi blackish; style of the female black *sackeni* Williston.
   Posterior femora at most brown, the tarsi reddish brown; style of female antennae reddish .....*subnitens* Cockerell.
3. Pile of the second abdominal segment tawny or fulvous with a reddish brown pilose band behind the middle; abdomen wholly black in ground color; anterior four tarsi reddish (female only) .....*volaticus* Williston.
   Pile of the second segment not decidedly tawny, more luteous or pale yellowish, never fulvous, abdomen almost always considerably reddish in ground color; if all black the anterior four tarsi are reddish brown .....4.
4. Abdomen all black or with a broad, continuous median black stripe; second segment in the female with a complete black hind margin; pile of the thorax mainly whitish yellow, rarely somewhat reddish yellow; postalar calli almost always black above, rarely reddish brown; wing veins mostly brown; venter more whitish pilose .....*maculatus* n. sp.
   Abdomen never all black; in the male with or without an interrupted black median stripe; in the female the second segment never with a complete black posterior margin; pile more yellow often with a luteous or slightly reddish tinge before the wings; veins of the wings brownish yellow; venter whitish yellow pilose .....*flavus* n. sp.

Rhynchocephalus maculatus n. sp.

Antennal style not enlarged apically; second posterior cell open; postalar calli never pure reddish on top, usually dull brownish or black; abdomen of male with a broad, median uninterrupted black stripe; sixth segment all black, rarely with small, transverse basal reddish spots; of the female with the second to fourth segments more or less reddish, but sometimes practically all blackish; usually with a broad median blackish stripe and red sides; pile yellow, rarely with an olivaceous or fulvous tinge. Length, 10.5 to 14 mm.

Male. Face whitish yellow pilose, usually a few black hairs across above the oral opening; ground color reddish yellow, more brownish in the middle of the face. Mouth parts with the labium black, rarely reddish on the basal fifth, the other parts reddish. Pile of the frontal triangle similar to that of the face; black above and usually between the narrowly separated eyes, although it may sometimes be brownish or brick red here. Vertical triangle small, dull brownish, with short, black, rather sparse pile. Occiput concave, yellowish white pilose. Antennae reddish; third segment cordate; arista with the second segment a little longer than the first, the third twice as long as the first two combined, curved outward and downward apically, sharply pointed, not at all enlarged apically.

Dorsum of the thorax dull black, almost opaque in well preserved specimens; on each side of the middle in front with a more or less distinct, usually

obscure reddish triangle; also reddish about the base of the postalar calli, the top of the calli always black or brown. Pile pale yellowish, usually largely mixed with black, especially in front, on the sides and before the scutellum; on the pleura whitish yellow; mixed yellowish and black on the scutellum which is never reddish in ground color; on the squamae usually mixed with considerable black or brown.

Femora reddish yellow, the hind ones luteous, compressed; tibiae brownish red or reddish, the hind ones more blackish; tarsi slightly darker than their tibiae, the hind ones black. Pile on the femora shining whitish yellow; on the tibiae and tarsi chiefly brownish or black. Claws reddish, the apical half black; pulvilli reddish, their apices usually black.

Wings hyaline, the bases brown; veins brownish; second posterior cell open.

Abdomen yellowish red, the hind margins of each segment, a broad median stripe, expanding somewhat at the sutures, the fifth segment, except sometimes an oval basal spot on either side of the middle and the following segments wholly, shining black or brown. Pile yellowish on the base of the abdomen, and on the sides and apices of all the segments; on the apical third of the second, on the basal half or more of the remaining segments, and very conspicuous basal tufts on the sides of the second to fifth segments, black. Venter with silvery yellowish pile.

Female. Front at the vertex about one-third the width of the face at the oral margin; chiefly black pilose, with appressed yellow hairs intermixed on the lower half; the color rather brownish above.

Abdomen never so extensively reddish; usually the second segment, except the apex and median line, and the basal half or more of the third and fourth on either side of the median stripe, not reaching the lateral margins, reddish, often only obscurely so. Lamellae of the ovipositor strongly curved, but this character is variable.

Holotype, male, Lawrence, Kansas, July 8, 1922, (C. H. Curran).

Allotype, female, same data.

Paratypes: five males and six females, same data; one male, Sumner Co., Kansas, 1916, (R. H. Beamer); one female, Waubaunsee Co., Kansas, (Forrest Anderson). Types in the University of Kansas Museum and the author's collection.

This species is very distinct from any previously described, but is closely related to *R. flavus.* It is distinguished from that species by the much wider median abdominal black stripe, usually distinctively paler pile, and almost invariably conspicuous black pile on the squamae, and the postalar calli are always darker. The apex of the second abdominal segment is always distinctively black or brown (never completely so in *flavus.*) They are both readily distinguished from *volaticus* Williston by the much paler pile and darker tarsi, more black pilose front, etc.

Rhynchocephalus flavus n. sp.

Second abdominal segment never with a complete black posterior fascia; median longitudinal stripe rarely complete, often entirely obsolete in both sexes;

pile of the anterior half of the thorax fulvous yellow. Length, 10 to 14 mm.

Male. Face pale luteous yellow in ground color, with bright whitish yellow pile, a little more yellow than in *maculatus,* usually without any black hairs above the mouth edge. Front grayish, with yellow pile; pile black above, usually rusty reddish or yellow between the eyes, rarely brownish. Vertical triangle dull brownish with short brown or fulvous scale-like hairs, and a few black ones. Occiput concave, with sulfur yellow pile. Antennae reddish yellow; third segment narrowly cordate; first and second segments of the style subequal in length, sharply pointed, curving outward and downward apically, not at all thickened. Labium black, the other parts of the proboscis reddish.

Thorax dull blackish; a median reddish line always more or less distinct on the middle, and sometimes an obscure anterior dash on either side reddish: postalar calli and disc of the scutellum always reddish. Pile of the dorsum yellowish, on the disc and posteriorly with more or less olivaceous tinge; always yellow or reddish-yellow laterally; rarely any black or brown hairs on the squamae but often some reddish ones.

Legs reddish yellow, the tibiae and tarsi more reddish; posterior tibiae and tarsi black. Pile whitish yellow on the femora; on the anterior tibiae mostly reddish or brownish, always rusty reddish on the inside; on the remaining tibiae chiefly black. Claws reddish, the apical third black; pulvilli reddish, their apices sometimes black.

Wings hyaline, their bases brownish yellow; veins all luteous; second posterior cell open.

Abdomen all reddish yellow or with a narrow median more or less interrupted shining brownish line, the sixth and seventh segments sometimes wholly and the fifth sometimes apically, shining black, the posterior margins of the second and third segments never distinctly blackish. Pile pale yellowish, with more or less olivaceous tinge, the narrow subapical margin of the second and apparently more or less of the bases of the following three segments, with brownish or blackish pile, but none of the specimens are perfectly preserved; at any rate all of these segments show appressed sparse yellow pile and on the third to fifth segments there is the usual basal tuft of black hair. The venter is silvery yellowish pilose, with a slight olivaceous tinge.

Female. Front opaque ochre-yellow, more grayish on the triangle above the antennae; with chiefly yellow pile, but some black hairs on the upper two-thirds; along the eyes always entirely yellow; ocellar triangle chiefly black pilose.

Thorax usually with the side margins and stripes about half way between the sides and middle line reddish, the middle line grayish or reddish; postalar calli always reddish.

The abdomen is rarely as in the male, usually having a median line which is interrupted on the anterior half or less of each segment. In one specimen the abdomen is entirely blackish beyond the fourth segment, but usually the fifth and sixth are chiefly reddish or have elongate basal spots which occupy over half the length of the segment and reach almost or quite to the sides.

Holotype, male, Harper Co., Kansas, 1916 (R. H. Beamer)

Allotype, female, Sumner Co., Kansas, 1916 (R. H. Beamer).

Paratypes, two males, Harper Co., 1916; one male, ten females, Sumner Co., 1916; male, Bourbon Co., Kas., 1915; male, Cherokee Co., Kas., 1916, (all R. H. Beamer); female, Wabaunsee Co., Kansas, (Forrest Anderson).

This species will be readily distinguished from the preceding by the much more extensively light color of the abdomen and thorax, the lighter wing veins and bases, and the much lighter front of the female. The front seems to be slightly longer.

Rhynchocephalus volaticus Williston.

I have before me a type female from Florida. This species is readily distinguished from the two foregoing by its more reddish yellow legs, entirely brownish abdomen and brownish yellow pile on the second segment; the apical third of the second and the bases of the two following segments with reddish brown pile. The ovipositor does not seem to be broadened apically as it is in the two foregoing. The pile is brighter and more fulvous throughout. According to Williston's figure the wing venation is practically identical in the three species. The abdomen is broader and less elongate than in related species.

Rhynchocephalus subnitens Cockerell.

I have four female specimens which I believe belong to this species but they are all larger (10 mm.) than Cockerell gives for the type. They have, however the strong olivaceous tinge to the pile (greenish gray, Cockerell). The legs are reddish, the femora, except the apices, brownish or obscurely so; the antennal style is reddish and is a little enlarged before the sharply pointed apex. The second posterior cell is pedicellate apically; there is some black pile intermixed on the abdomen and thorax.

Rhynchocephalus sackeni Williston.

I have a type male from Washington and a female from California before me. The male has decidedly longer, more yellow pile than in *subnitens* and the femora are much darker; the tarsi are fuscous except basally. In the female, which may not be conspecific, there is more black hair on the thorax and abdomen and the femora and tarsi and the apical fifth of the hind tibiae, are quite black. The pile in this specimen is not quite so bright, but is decidedly more yellow than in *subnitens*. It also has the antennal style black and enlarged apically, but it is reddish in the male and quite simple.

TWO VERY COMMON MISTAKES OF ENTOMOLOGICAL WRITERS

BY RALPH HOPPING
Vernon, B. C.

Two mistakes have become so prevalent among entomological writers that it would seem to justify the following observations. 1. The use of the word *"punctuation"* instead of *"punctation"*. There are few North American writers who have not made this mistake. Notable exceptions are Dr. LeConte, possibly because he generally wrote his descriptions in Latin, and Dr. Horn, who generally used the words 'punctate' or 'punctured'. When we use the word *punctuation* we certainly do not mean that an insect has commas, semicolons, etc. This mistake is most prevalent among Coleopterists. 2. The habit of many U. S. entomologists of recording the distribution of species only as far as the international boundary between the United States and Canada.

If the literature did not contain any references to Canadian distribution this might be excusable, but some writers have even gone so far as to include Alaska without any reference to British Columbia, continuing the distribution with the states of Oregon or Washington. If material from Canada is not on hand a note to the Division of Systematic Entomology, Entomological Branch, Ottawa, Ont., or any entomologist in Canada will give them the required information. It always has seemed ridiculous to me that any distribution could stop at an international boundary. Even species supposed to be local are often much more widely distributed than we suppose. An instance in support of this is that of *Saperda hornii* Joutel, supposed to be confined to Central California. Three specimens of this species have been caught in British Columbia and lately one was sent me from Manitoba by Mr. J. B. Wallis of Winnipeg.

A NEW RACE OF SPHINX GORDIUS (LEPID.)*

BY J. MCDUNNOUGH,
Ottawa, Ont.

Sphinx gordius var. **campestris** n. var.

Differs from typical *gordius* from the east in its smaller size and more contrasted maculation, the costa and inner margin of forewing being shaded with deep smoky whilst the central portion of the wing is suffused with whitish shades, especially preceding the wavy subterminal dark line. Between this line and the outer margin of the wing the terminal area is heavily suffused with deep smoky, in contradistinction to *gordius borealis* Clark in which this region is sprinkled with whitish, more as in the typical form. The dark intravenular streaks are reduced, much as in *gordius oslari* R. & J. from Colorado, but from this race the smaller size and the better defined transverse lines will distinguish it. Expanse 70 mm.

Holotype—♂, Aweme., Man., July 2, 1926, (N. Criddle); No. 3256 in the Canadian National Collection, Ottawa.

Paratypes—1 ♂, same locality (no date); 1 ♂, Fairlight, Sask., July, 1910, (T. N. Willing).

BOOK REVIEW

The Plant Quarantine and Control Administration—By Gustavus A. Weber, Service Monograph of the United States Government, No. 59, pages 1-x, 1-198. The Brooklings Institute, Washington, D. C., 1930. Price $1.50

This volume is one of a series prepared and published by The Brookings Institution on the history, organization and activities of the various Departments of the United States Government. "These monographs are all prepared according to a uniform plan. They give: first, the history of the establishment and development of the service; second, its functions, described not in general terms, but by detailing its specific activities; third, its organization for the handling of these activities; fourth, the character of its plant; fifth, a compilation of, or reference to, the laws and regulations governing its operations; sixth, financial statements showing its appropriations, expenditures and other data for a period of years; and finally a full biblio-

*Contribution from the Division of Systematic Entomology, Entomological Branch, Dept. of Agric., Ottawa.

graphy of the sources of information, official and private, bearing on the service and its operations."

In the section entitled "History", a review is given of the insect and pest legislation enacted by Congress including the Plant Quarantine Act of 1912, the reasons for the establishment of Quarantine 37, and a summary of the legislation affecting such projects as the European corn borer, Mediterranean fruit fly, Japanese beetle, white pine blister and black stem rust. Under "Activities" a summary of the various projects is given, and the section dealing with "Organization" lists the positions with salaries under the various projects. Included in the "Appendix" are the laws administered by the organization, financial statement, publications and bibliography, etc.

This work is of inestimable value to all those who are in any way interested in insect or plant disease legislation. It should prove to be most useful not only as a current reference as showing the activities that are being carried out today, but also as a general reference in that it records the steps that have been taken to develop the Plant Quarantine and Control Administration to its present size and state of efficiency. L. S. McLAINE.

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